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CONDITIONING COTTON FOR INCREASED RESPONSE TO DEFOLIANT CHEMICALS[1]

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ABSTRACT

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Chemical defoliants frequently cause varying amounts of abscission when applied to cotton (*Gossypium hirsutum* L.), and almost always become less effective as the temperature is lowered to near 16°C. The objective of this research was to evaluate the effect of TD 1123 (potassium 3,4-dichloroisothiazole-5-carboxylate) in altering leaf abscission response of cotton to the defoliant chemicals DEF (S,S,S-tributyl phosphorotrithioate), dimethipin (2,3-dihydro-5,6-dimethyl-1,4-dithiin 1,1,4,4-tetraoxide), and thidiazuron (N-phenyl-N′-1,2,3-thiadiazol-5-ylurea) in relatively low temperature environments. The tests were conducted in one temperature-controlled greenhouse experiment and two field experiments (early and late season). Measurements of leaf abscission, regrowth, seedcotton yield, and various boll properties were made and the data analyzed statistically.

Defoliation response to each of the three defoliant chemicals was significantly enhanced in both the low and high temperature regimes when TD 1123 was applied ten days before the defoliant treatment. The enhancement, however, was more pronounced in the low temperature environment. In addition, regrowth was reduced on the TD 1123-treated plants in both temperature regimes. Seedcotton yield, lint percent, and boll components were not significantly affected by any chemical treatment.

The research indicates that TD 1123 can be an effective harvest-aid chemical on cotton when plant and environmental conditions are not conductive to easy defoliation.

INTRODUCTION

Although the use of chemicals to prepare cotton (*Gossypium hirsutum* L.) for mechanical harvest has been commercially successful for over 30 years,

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there are still many failures. Most failures are related to either plant or environmental conditions that are not conducive to maximum plant response to the defoliant chemical (Hall, 1951; Brown and Hyer, 1954; Lane et al., 1954; Taylor 1981). Most chemicals currently suggested for cotton defoliation are effective, provided proper application is made and the weather and plant conditions are conducive to maximum activity.

In efforts to increase plant response to defoliants under adverse environmental conditions, numerous compounds have been used either as additives to the defoliant mixture (Brown, 1957; Cathey and Hacskaylo, 1973; Cathey and Barry, 1977) or as "conditioner treatments" applied prior to the defoliant chemicals (Arle, 1976; Cathey and Barry, 1977; Cathey, 1978). However, the effectiveness of many of these products has not been well established.

Potassium 3,4-dichloroisothiazole-5-carboxylate (TD 1123) is an experimental growth regulator chemical that tends to induce senescence in cotton leaves (Cathey et al., 1981) and to reduce late-season vegetative and reproductive development (Kittock and Arle, 1977; Thomas et al., 1979).

In addition, there is some evidence that defoliation is enhanced in TD 1123-treated plots (Arle, 1976; Kittock and Arle, 1977; Cathey, 1978). The objective of the research reported here was to evaluate the effectiveness of TD 1123 as a conditioner for chemical defoliation in a low temperature regime.

This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA nor does it imply registration under FIFRA.

MATERIALS AND METHODS

Greenhouse experiment

Cotton plants cv. 'DES-56' plants were grown during 1979 in 20-cm clay pots filled with masonry sand and kept moist by frequent watering and periodic additions of a complete nutrient solution. One week after seedling emergence the plants were thinned to one per pot and one pot comprised a treatment. Treatments were replicated eight times in a randomized block design and consisted of sequential treatments of TD 1123 and various defoliant chemicals. Treatments consisted of an untreated control, DEF (S,S,S-tributyl phosphorotrithioate) at 1.26 kg/ha, thidiazuron (N-phenyl-N′-1,2,3-thiadiazol-5-ylurea) at 0.17 kg/ha, dimethipin (2,3-dihydro-5,6-dimethyl-1,4-dithiin 1,1,4,4-tetraoxide) at 0.34 kg/ha, and TD 1123 at 0.34 kg/ha applied 10 days before each of the three chemical treatments. The TD 1123 applications were made at 9 weeks after planting and the defoliant applications made 10 days later. The chemicals were diluted with water and then applied with a CO_2 regulated pressure sprayer.

Immediately after the defoliant application four replications of each treatment were moved to a separate greenhouse compartment and the plants in each compartment arranged in a randomized block design with four replications. The environmental controls were adjusted to maintain day/night temperatures in the two compartments at 29°C/21°C (warm) and 21°C/13°C (cool). Total defoliation percentages were determined by leaf counts prior to the defoliant treatments and 11 days later. The plants were then mechanically defoliated and held for 17 additional days for regrowth determinations. Regrowth was determined by dry weight measurements of all new vegetation at 28 days after the defoliant applications.

Field experiments

'DES 56' seeds were planted 22 Apr. 1980 on Bosket fine sandy loam (a fine loamy mixed thermic Mollic Hapludalf) fertilized with 112 kg N/ha. Plant population was approximately 120 000 per ha in rows spaced 1 m apart. Standard production practices were followed throughout the growing season. Treatments were randomized in complete blocks with four replications and applied to four-row plots, 40 m long. Data were collected from the two center rows only. Treatments were applied in 187 liters of water per ha with a high clearance ground spray machine equipped with two TX-10 Cone Jet nozzle tips per row (one over the row and one over the middle). The sprayer was operated at 4 km/h and 275 kPa pressure.

Two field experiments were conducted that had identical chemical treatments but different application dates. Chemical treatments were the same as those used in the greenhouse experiment. The defoliant chemicals were applied on 10 September in one experiment and 2 October in the second. Defoliation and regrowth estimates were made by visual observations and 8 m of row were hand-picked from each plot for seed cotton yield data. Estimates of boll size, seed index, lint index, lint percent, seeds per boll,

TABLE 1

Maximum and minimum temperatures (°C) during early and late season defoliation of field grown cotton (1980)

Early season			Late season		
Date	Max.	Min.	Date	Max.	Min.
Sept. 10	36.7	20.0	Oct 2	27.2	13.9
11	33.9	16.7	3	25.0	10.6
12	33.9	17.8	4	20.6	9.4
13	36.7	20.0	5	26.1	6.7
14	35.6	22.2	6	18.3	4.4
15	37.8	21.1	7	21.1	5.6
Mean	35.7	19.6	Mean	23.0	8.4

germination percent, and seedling vigor were made from 50-boll samples collected from each plot. Maximum—minimum temperatures that occurred during the 6 days that followed the defoliant chemical treatment applications in the two field experiments are shown in Table 1.

Standard methods were used for all data analysis, and differences between means were evaluated by Duncan's multiple range test.

RESULTS AND DISCUSSION

Greenhouse experiment

Cotton leaf abscission response to defoliant chemicals was influenced by temperature regime and TD 1123 conditioning treatment (Table 2). There was a differential response to the three defoliants in each of the test environments, but the response to each chemical was increased significantly when the day/night temperature regime was increased from 21°C/13°C to 29°C/21°C. Other research has also alluded to the effect of temperature on defoliant activity. Lane et al. (1954) established 16°C as the temperature requirement for minimal leaf response to most defoliants, and

TABLE 2

Effect of TD 1123 on immature cotton response to defoliant chemicals in two greenhouse temperature regimes[a]

Treatment	Rate (kg/ha)	Defoliation (%)[b]		Regrowth (g dry wt per plant)[c]	
		Warm	Cool	Warm	Cool
TD 1123[d]					
DEF	1.26	83 b A[e]	74 a B	5.8 c A	3.7 c B
Thidiazuron	0.17	93 a A	66 b B	2.6 d A	2.3 cd A
Dimethipin	0.34	87 ab A	79 a B	2.5 d A	2.2 d A
No TD 1123					
DEF	1.26	74 cd A	46 c B	10.3 a A	9.8 a A
Thidiazuron	0.17	79 c A	39 c B	7.4 b A	6.8 b A
Dimethipin	0.34	70 d A	62 b B	7.8 b A	6.3 b B

[a]Temperature regimes were 29°C days and 21°C nights (warm) and 21°C days and 13°C nights (cool).
[b]Defoliation percent determined at 11 days after defoliant application.
[c]Regrowth determined at 28 days after defoliant application.
[d]TD 1123 (0.34 kg/ha) applied 10 days before defoliant chemicals.
[e]Lower case letters are used to compare chemical treatments and upper case letters to compare temperature regimes. Values within columns followed by the same lower case letter are not significantly different at $P = 0.05$. Values within rows for a particular measurement followed by the same upper case letter are not significantly different at $P = 0.05$.

a diurnal temperature average of 24°C for acceptable levels of chemical-induced defoliation. They found that plant response to a defoliant doubled with each 10 degree rise between 15°C and 35°C. However, Taylor (1981) reported that temperature requirements for thidiazuron activity was 3 to 5 degrees higher than that reported for most other defoliants. Conversely, Ames (1981) found that acceptable levels of dimethipin activity occurred when temperatures were 3 to 5 degrees below that required by most other defoliants.

Pretreatment with TD 1123 also caused an increase in defoliation response to each of the defoliant chemicals in both greenhouse temperature regimes (Table 2). Although the TD 1123 effect on the relative activity of the defoliant chemicals was altered by temperature change, the enhancement effect on each defoliant was more pronounced in the cool environment. Results from other research (Elmore et al., 1978; Cathey et al., 1981) indicate that sequential treatments of TD 1123 and DEF have an apparent synergistic effect on several physiological events that occur during the abscission process. Most parameters that normally are affected by a defoliant chemical were not altered by TD 1123 but became more pronounced and occurred earlier in the sequentially treated leaves. While these earlier studies were concerned only with the defoliant chemical DEF, results from the studies reported here indicate a similar effect of TD 1123 on the activity of other defoliant chemicals.

The development of regrowth vegetation on greenhouse plants following chemically-induced leaf abscission was also influenced by temperature regime and TD 1123 treatments (Table 2). The relative regrowth inhibition effects of these variables were similar to those for leaf abscission; i.e. reduced regrowth on TD 1123-treated plants in both temperature regimes, and slightly more regrowth on plants in the warm temperature regime.

Field experiments

Results from field trials with TD 1123 and defoliant chemicals (Table 3) suport those from the greenhouse study though the experimental conditions in the studies were at variance in some respects (immature greenhouse plants vs. mature field plants, and controlled greenhouse temperature vs. uncontrolled field temperature). Both the defoliation percentage and regrowth effect of the various treatments were similar in the field and greenhouse studies.

The performance of all three defoliant chemicals was reduced significantly when the test periods were changed from early (warm) to late (cool) season. In addition, the relative effectiveness of the three chemicals was altered. The effect of TD 1123 pretreatments on altering the effectiveness of the defoliants was also somewhat different during the two test periods. The pretreatment in the early test enhanced the activity of DEF and dimethipin but had no effect on thidiazuron, whereas in the late test the activity of DEF and thidiazuron was enhanced but that of dimethipin was not significantly affected.

The effects of environment, TD 1123, and defoliant chemicals on regrowth development of field-grown cotton (Table 3) were similar to those found in the greenhouse test, except that the TD 1123 and environment effects were slightly less pronounced in the field tests. TD 1123 pretreatments reduced regrowth development on DEF-treated plants in both the early and late season trials, but had no significant effect on plants treated with either dimethipin or thidiazuron. Regrowth development in the thidiazuron-treated plots was significantly less than that in any of the other plots during each of the field tests.

The treatments had no effect on seed cotton yield, percent lint, and boll components (seed index, lint index, boll size, and seed germination). Neither were the fiber properties length, strength, and micronaire affected by any chemical treatment.

Results from these studies indicate that defoliation response of cotton plants to conventional defoliant chemicals can be improved significantly if TD 1123 is applied 10 days before the defoliant treatment. This could

TABLE 3

Effect of TD 1123 on plant response to defoliant chemicals during early and late season defoliation of field grown cotton[a]

Treatment	Rate (kg/ha)	Defoliation (%)[b]		Regrowth index[c]	
		Early season	Late season	Early season	Late season
TD 1123[d]					
DEF	1.26	94 a A[e]	71 bc B	2.4 b A	2.2 b A
Thidiazuron	0.17	97 a A	65 cd B	1.2 c A	1.0 c A
Dimethipin	0.34	91 a A	82 a B	2.0 b A	2.0 b A
No TD 1123					
DEF	1.26	82 b A	62 d B	3.5 a A	3.0 a A
Thidiazuron	0.17	96 a A	50 e B	1.6 c A	1.2 c A
Dimethipin	0.34	81 b A	75 ab A	2.7 ab A	2.3 ab A
Control		20 c A	12 f A	3.4 a A	2.7 ab A

[a]Defoliant chemicals were applied on 10 September (early season) and 2 October (late season).
[b]Percent defoliation determined 12 days after defoliant application.
[c]Regrowth estimations made 21 days after defoliant application and indexed as 1 = none or very light; 2 = light; 3 = moderate; 4 = heavy; 5 = very heavy.
[d]TD 1123 (0.34 kg/ha) applied 10 days before defoliant chemicals.
[e]Lower case letters are used to compare chemical treatments and upper case letters to compare seasons. Values within columns followed by the same letter are not significantly different at $P = 0.05$. Values within rows for a particular measurement followed by the same letter are not significantly different at $P = 0.05$.

prove to be an important harvest-aid practice in areas where cotton tends to be difficult to defoliate, and especially when environmental conditions are not conducive to easy defoliation. The results also indicate that TD 1123 tends to reduce regrowth, which could be an added advantage when conditions are conducive to continued late-season vegetative development (Hopkins and Moore, 1980).

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